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have no influence upon the certainty of recognition. Nor should the time elapsing, nor personal conditions, nor practice have any considerable influence. The results of Dr. Lehmann's experiments gave support to all these inferences. Hence he concludes that the theory of association by contiguity explains all the phenomena of recognition, and that the theory of association by similarity, which cannot explain them all and sometimes is in conflict with experience, is superfluous.

W. H. B.

The Senses of Animals. SIR JOHN LUBBOCK. pp. xxix, 292. International Scientific Series. D. Appleton & Co., N. Y., 1888.

Having been obliged to look up a great deal of literature on the subject of the senses of animals, Lubbock has put together into a book the information laboriously arrived at, for the sake of making the path of the next explorer easier than his own has been; and he has thrown in some observations of his own, additional to those heretofore published, besides some acute criticisms of the reasoning of other observers. The result is somewhat heterogeneous, but it is interesting all the same; it is not necessary that every book that is printed should be a harmonious whole. The list of books and papers consulted by him is very long, but Graber's latest work on the brightness-sense and the color-sense of animals seems not to have reached him at the time he wrote. This is strange, because it bears the date of 1884; and it is unfortunate, because it may be considered as the only absolutely thorough and scientific experimental investigation of those senses in animals that has yet been made. Graber determined the absorption spectrum of all his colored glasses and colored solutions, and the exact intensity of the light which they transmitted; he found out how strong the preference of each animal was for brightness or for darkness before testing its preference for colors; he offered his animals the choice between only two compartments at a time, rightly considering that to ask them to bear in mind their sensations long enough to choose between five or six was putting too great a strain upon their mental powers; he made with each pair of colors two sets of experiments, once with one color the brighter and once with the other color the brighter. None of all these precautions were taken by Lubbock. Graber worked under many disadvantages and with much lack of means for procuring desirable apparatus; he speaks with real grief of the fact that Lubbock, with rich laboratories at his command, did not proceed in a more systematic fashion. As regards results, concerning bees, for instance, they obtain for preference-coefficients compared with red, respectively,

	R	Y	G	B	W
Lubbock,	1	1.02	.96	1.5	1.19
Graber,	1	2	2	6	18

The only agreement is that, of the colors, blue is the favorite. Lubbock finds that white is only slightly preferred to red; Graber that it is visited eighteen times as frequently. Graber finds besides that both blue and white with ultra-violet are three times as agreeable to bees as without ultra-violet.

The book contains much that is interesting on the instincts of some animals, especially bees, and on the intelligence which they

occasionally, though rarely, show when obstacles are put in the way of their carrying out their usual plan of action. Some wasps always put exactly five half-dead caterpillars in the cell of a male grub and ten in the cell of the female. Does this show that they can count? If not, it shows that they can do something else which answers the purpose just as well. Ants always recognize the members of their own community, though they may be 500,000 in number; this is not done by means of any sign or password, for it can still be done when the one recognized is senseless from intoxication. Experiments which were taken as showing that bees have a special sense of direction are proved to be quite inconclusive; the returning to the hive must have been done by mere recognition of known objects. There is an admirable résumé of the discussion as to whether the eyelets of compound eyes give each the whole image or only a small part of it; the latter opinion is plainly made out to be the better one. Lubbock regards it as mysterious that the rods and cones of the vertebrate eye should point outwards instead of inwards, though he says that it has some connection with development. It is difficult to see how there could have been any other arrangement, when it is remembered that the vertebrate eye is first a bladder and then a double cup pushed forward from the brain, instead of being a depression in the outer integument. The reason for this development, according to Balfour and Carrière, is simply that the portion of the ectoderm which was destined to give rise to the eyes has, in vertebrates, already been drawn in to form the brain. Neither is it mysterious that animals should see ultra-violet rays of light which to us are indistinguishable from blackness. There is good reason to believe that the reason we do not see ultra-violet is because the ultra-violet rays are strongly absorbed by the refracting media of the eye; an animal with a smaller eye would naturally not suffer so much from this inconvenience.

C. L. F.

Zum Mass der Schallstärke. DR. PAUL STARKE. Wundt's Philos. Stud. V. 1. 1888.

In completion of a former study on the question of the relation of the height of fall and of the weight of a falling body to the intensity of the sound that it produces, the author reports the verification of his former results. He finds that within the limits of error the sound is directly proportional to the height, with a constant weight, and to the weight, with a constant height. The different results of former investigators arose from their neglect of the influence of the order in time of the standard sounds and those to be compared, and of the influence of Weber's law. The sounds were produced by the fall of ivory balls of 8.07 and 16.12 grams weight, on an ebony plate from heights of from 100 to 600 mm.

Tonstärkmessung. ERNST GRIMSEHL. Wiedemann's Annalen, No. 8b, 1888. Also *in extenso* in Programmabhandlung des Realgymnasiums zu Hamburg, 1888.

Starting from an observation of Lord Rayleigh's that thin plates in a resonant column of air tend to place themselves perpendicular to the axis of the column, the author has constructed a phonometer in which the degree of rotation of a thin disk of mica measures the